nanofiltration had a little less total score due to higher toxicity of soluble arsenic compounds (in concentrate from membranes) compared to insoluble arsenic compounds (immobilized on adsorbents).

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RISK OF CHEMICAL PLANT IMPACT ON THE ENVIRONMENT

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РИЗИК ВПЛИВУ ХІМІЧНОГО ПІДПРИЄМСТВА НА НАВКОЛИШНЄ СЕРЕДОВИЩЕ

Запорожець Ю. А.

РИСК ВЛИЯНИЯ ХИМИЧЕСКОГО ПРЕДПРИЯТИЯ НА ОКРУЖАЮЩУЮ СРЕДУ

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This paper present an algorithm that allows quantitatively evaluate chemical risks of environmental changes caused by an industrial facility to the hydrosphere and atmosphere as component of the environment during its scheduled operation.
Keywords*: ecological risk, chemical risk, anthropogenic object, pollutants*

В статті представлено алгоритм який дозволяє кількісно оцінити хімічний ризик змін навколишнього середовища під впливом промислового підприємства, при його регламентній роботі, для гідросфери та повітря як компонентів навколишнього природного середовища.
Ключові слова*: екологічний ризик, хімічний ризик, техногенний об’єкт, забруднюючі речовини*

В статье представленно алгоритм который позволяет количественно оценить химический риск изменений окружающей среды под воздействием промышленного предприятия, при его регламентной работе, для гидросферы и воздуха в качестве компонентов окружающей природной среды.
Ключевые слова*: экологический риск, химический риск, техногенный объект, загрязняющие вещества*

Following numerous accidents and disasters occurred in the last twenty years, the humankind has gradually transitioned from 'null risk' concept to 'sensitive risk' concept, which helps to compare the impact of hazardous chemical substances on the environment.

Presently, chemical pollution remains one of the major unsolved problems of the humankind. One source of pollution can often trigger a chain of unforeseen negative consequences on the environment; therefore, it is essential not only to improve existing technologies or create new ones but also to evaluate the corresponding ecological risk of these technologies. Furthermore, it is necessary to analyze all possible sources and ways of environmental pollution in detail, consider both direct effect and interaction between them.

Since the first stages of researches on the processes of environmental pollutions – distribution of pollutants in the atmosphere, soil contamination during filtration [1], impact on composition of groundwater, dispersion of pollutants in the water – a great deal of studies [2] have been dedicated to them.

Assessing chemical risk of industrial facility

The choice of a method for assessing a chemical risk of industrial facilities can greatly affect the quality and adequacy of evaluation and conclusions about safety levels of industries. Therefore, improvement of mathematical tools and development of an algorithm for quantitative risk assessment of dangerous chemical facilities under normal operation are forward-looking and highly topical issues at the present time.

The method for quantitative risk assessment is based on the Chemical Substance (CS) Cycle scheme in the system 'industrial factory-environment'.

During our research on the subject matter, we considered development of chemical risk related to the emission of hazardous substances to the hydrosphere and air, as shown in Figure 1 in solid line, that is emission to surface waters and soil, evaporation from the surface of a reservoir (puddles, septic tanks) and movement in the air. We have designed an algorithm based on the pattern, Figure 2, which allows assessing chemical risk of an industrial plant to the hydrosphere and air environmental components.

Energy is the key factor in the development of all sectors of the economy; it grows rapidly and has impressive scale of production. In that regard, energy industries play major role in polluting environment from burning of fossil fuels that get into the air and water basins, greatly affect groundwater and reduce productivity of soil.

Example of algorithm application

We have analyzed impact risk from Kharkiv CHPP-5 on the environment based on data.

The 'index-risk' method is used to determine impact risk level of a hazardous chemical facility on the components of the environment.

To calculate risk of CHPP impact on the environment, we first need to calculate concentration change of substances at different distances from the facility.

The following formulas (1) are used to calculate value of the maximum ground level concentration of hazardous substances C_m with the emissions through a multi-flue stack (N flues), distance X_m where the maximum concentration C_m is obtained, and dangerous wind speed U_m:

$$C_m = C''_m + d_1 \cdot (C'_m - C''_m)$$
$$X_m = X''_m + d_1 \cdot (X'_m - X''_m) \quad (1)$$
$$U_m = U''_m + d_1 \cdot (U'_m - U''_m)$$

where C'_m - maximum surface concentration, determined at values of emission parameters for one barrel and emission power M; X'_m, U'_m - respectively, the distance at which the maximum concentration of harmful substances C_m is observed, and the dangerous wind speed U_m under the parameters of the emission of one barrel; C''_m - the maximum surface concentration at the emission power M, equal to the total power ejection from all trunks, X''_m U''_m distance, corresponding to the maximum concentration C''_m and the dangerous wind speed; d_1-dimensionless coefficient.

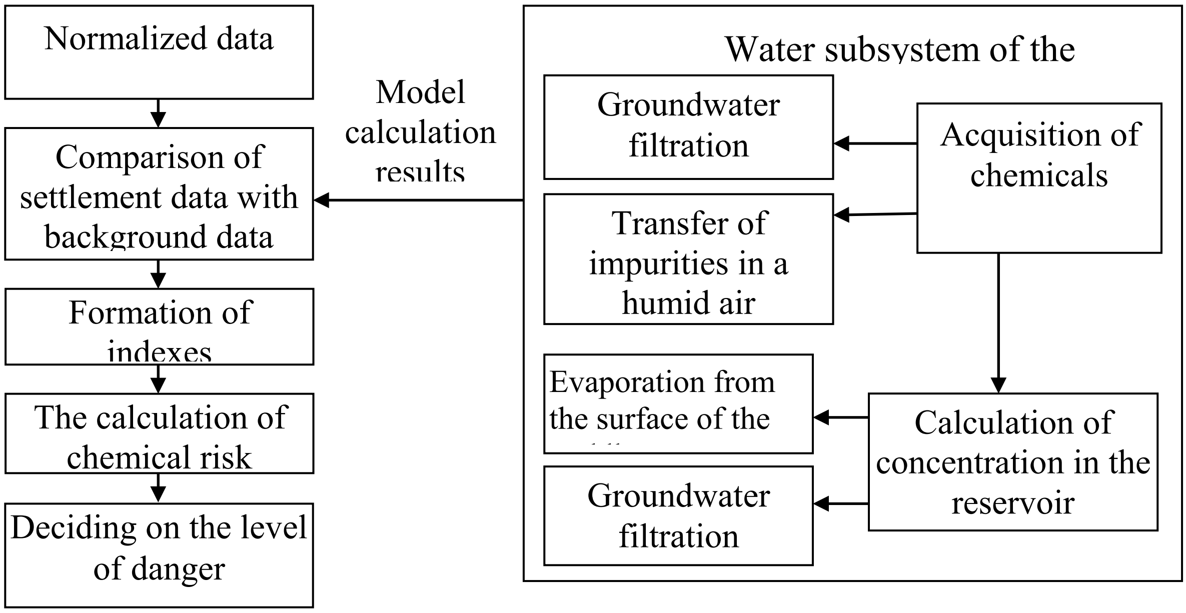

Fig. 1 Scheme of calculation of chemical risk of the enterprise in the method of "index-risk"

The relation [3] is used to determine quantitative risk assessment:

$$R_{kj} = A \cdot e^{B \cdot e^{D_{kj}}} \quad (2)$$

where R_{kj} - the risk of k- th stage on the j - th component of the environment, dimensionless; A, B – constants (A=4,99·10^{-6}, B=-7,557); D_{kj} – is the value determined by the k- th stage of the calculation of risk for the j component, which is calculated by the formula:

$$D_{kj} = -e^{I_{kj}-1} \quad (3)$$

where I_{kj} – index of pollution by the j- th component of the environment (atmosphere, hydrosphere) for the k-th stage of the calculation of risk, dimensionless.

Once we obtain actual values of emissions of hazardous substances (tons per year) and correlation values of emissions (nominal tons per hear) during Kharkiv CHPP-5 operation on different kinds of fuels, i.e. gas, residual fuel oil and coal, and know maximum permissible emissions (MPE) of hazardous substances from a source of contamination into the atmosphere, we can forecast negative impact on the environment. The calculation results of the coal-fired CHP plant are summarized graphically. Figures 2, 3 and 4 show graphic charts of change in carbon dioxide, sulfur and nitrogen concentrations respectively.

These graphs may lead us to a conclusion that risk remains permanent with change in CO concentration – unacceptable; whereas risk is reduced when concentration of NO_2 and SO_2 is also reduced.

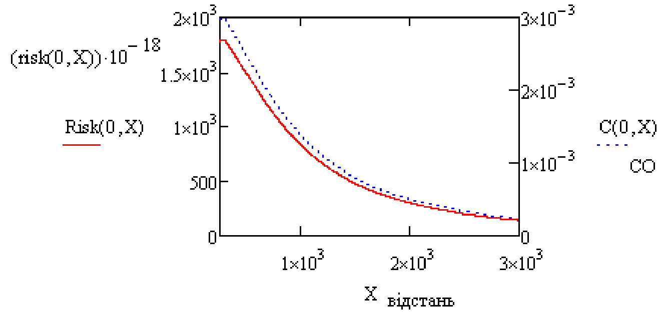

Fig. 2 Graphic representation of risk changes and concentration of carbon dioxide from a distance

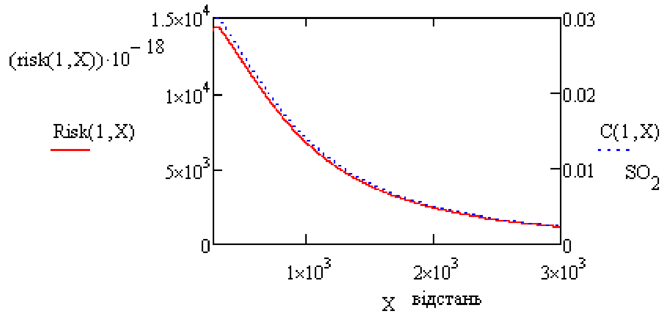

Fig. 3 Graphic image of risk change and concentration of sulfur from a distance

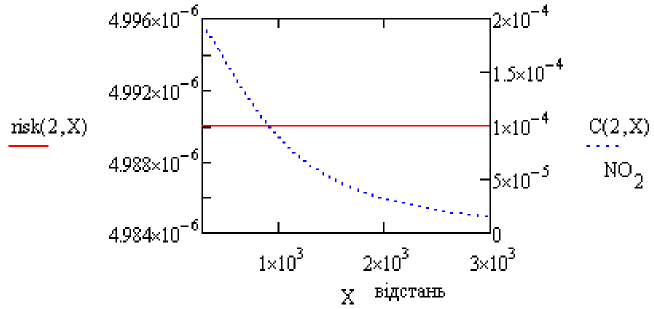

Fig. 4 Graphic image of risk change and concentration of nitrogen from a distance

CONCLUSIONS

The results on the emission of hazardous substances from CHPP-5 show that zone of ground level concentrations, which exceed the MPC level when CHP plant is coal and residual fuel oil operated, covers an area of 1 km in modeling at a distance of 3 km from the source of contamination. The area of maximum ground level concentrations of hazardous substances covers a sector of 1 km from the source which corresponds to high level of risk (unacceptable); medium level of risk (acceptable) is observed in the area from 1 km to the boundaries of the modeling interval.

The developed algorithm allows quantitatively assess risk of environmental changes from hazardous substances emitted by the industrial facility during its scheduled operation.

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